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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

NOV 9 1990

OFFICE OF
RESEARCH AND DEVELOPMENT

MEMORANDUM

SUBJECT: Meeting with Representatives of Chemetals Corporation

FROM: Stanley B. Durkee
Office of Technology Transfer
and Regulatory Support (H-8105)

DEC -

TO: Air Docket (LE-131)

On October 19, 1990, a meeting was held between EPA and representatives of the Chemetals Corporation. The meeting was requested by Chemetals, a supplier of manganese. Chemetals representatives presented a brief overview of Chemetals' product line and history, indicating that the company had 40 years of experience with manganese and were aware of no health problems. They said their data indicated there would be no problem associated with exposure to manganese from the addition of Methylcyclopentadienyl Manganese Tricarbonyl (MMT) to unleaded gasoline. They noted that MMT has been used in Canada for a number of years and that Environment Canada indicated it has no problem with its use. Chemetals representatives indicated they had previously submitted information to the docket on these points.

Subsequent discussion centered around potential health and exposure concerns related to manganese inhalation exposures. EPA representatives indicated that microenvironmental exposures to manganese and the distribution of exposures to manganese in a population (rather than annual ambient manganese averages) may be important considerations. EPA representatives pointed out that the absence of studies (as in the Canadian situation) does not indicate there is no problem. Chemetals representatives indicated they would place in the docket additional information related to the areas discussed.

The attached handouts were distributed by Chemetals representatives at the meeting.

Attachment

EPA attendees
Dr. John Skinner, Office of Research and Development
Dr. Peter Preuss, Office of Research and Development
Mr. Stanley Durkee, Office of Research and Development

Chemetals attendees
Mr. Christopher Shaper
Dr. Albert Kolbye, Jr. (Kolbye Associates)
Dr. Francis Keenan
Ms. Cynthia Irmer (Squire, Sanders and Dempsey)

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CHEMETALS INCORPORATED
MEETING WITH DR. JOHN H. SKINNER
October 19, 1990

AGENDA

- Overview -- Where Chemetals fits into the MMT Waiver Request process

- Summary of the Environmental Impacts of Manganese -- What is and what is not an Issue

- Summary of the Toxicological Impacts of Manganese -- Why Manganese levels in MMT do not give rise to the concerns expressed

- What are EPA's specific concerns regarding the Waiver Request

- What Answers, Information or Documents can Chemetals provide to EPA before November 4, 1990

A-9016
IV-E-9

STATEMENT OF KOLBYE ASSOCIATES IN THE SUPPORT OF ETHYL CORPORATION'S HITEC 3000 WAIVER REQUEST

--------S U M M A R Y--------

* Manganese is essential to human health.

* Manganese does not pose a public health risk at ambient levels.

* Manganese is excreted from the human body.

* Manganese is not a known carcinogen.

* Manganese is only neurotoxic to humans at high milligram inhalation exposure levels.

* Occupational safety inhalation standards are orders of magnitude greater than present or expected ambient air levels.

* Toxicity of manganese is different from and not related to the toxicity of lead.

* Use of hair sampling techniques to estimate human exposure to manganese had not been validated.

* While deficiencies of dietary intakes of iron and calcium increase manganese absorption, they are not directly relevant to the issue involved here.

KOLBYE ASSOCIATES
EVALUATION OF PROPOSED USE OF MMT

Kolbye Associates
7313 Helmsdale Road
Bethesda, MD 20817
July 20, 1990

INTRODUCTION:

This is a brief report of our scientific analysis and evaluation of the proposed use of HiTech 3000 as a manganese additive to gasoline.

We have conducted an extensive search of recently published scientific literature and critically evaluated these reports in conjunction with previous knowledge of the potential toxicity of various manganese-containing compounds.

OUR OPINION IN SUMMARY

We have no objection to the proposed use of MMT nor do we believe that any significant health problems will result from its use in this manner. In addition, future scientific research will continue to develop additional knowledge about traces of environmental manganese in various media such as ambient air. Any potentional hazard can be monitored continuously without any risk to public health. We see no reason whatsoever to deny the waiver for MMT.

1) MANGANESE IS ESSENTIAL TO HUMAN HEALTH.

There can be no question of the nutritional importance of manganese in the diet. Manganese is an essential co-factor and component of many enzymes, notably in the mitochondria. Deficiencies are well recognized in laboratory animals. In humans there is corresponding evidence but to a lesser degree of documentation. Obviously, the human body, through biological evolution, requires manganese and is experienced in metabolizing manganese compounds ingested in the diet. Variations of absorption and excretion exist, when infants, pregnant women, and older adults are compared. However, the only human disease problems attributed to manganese were caused by occupational inhalation exposures for protracted time-periods to high concentrations of manganese oxides (at levels of tens of milligrams per cubic meter of air).

2) MANGANESE DOES NOT POSE A PUBLIC HEALTH RISK AT AMBIENT LEVELS.

Manganese is the 12th most common element of the earth's crust. Airborne dust from ground soil is a major source of pulmonary exposure for humans, as is inhalation of air near ocean spray. There are many data on airborne levels of manganese compounds. In a recent Canadian report (1988),

urban levels were reported on the average to range from 65 nanograms per cubic meter to 166. In similar fashion both fresh water and salt water contain appreciable levels of manganese ranging from low to high micrograms per liter. Appreciable levels of manganese compounds occur in many foods notably certain grains and vegetables. It is estimated that humans ingest, on the average, between 4 and 9 milligrams of manganese per day in their diets. We can see that the most substantial sources of human exposure to manganese are dietary and far greater than those usually involved with inhalation. It is true that manganese, when inhaled and absorbed into the blood stream, can follow different pathways of distribution in the body. Most, however, will go to the liver within a short time and be metabolized and excreted. Some may directly enter the brain and here there is evidence of a longer biological half-life. However, the question of neurotoxicity clearly depends on dose. There is strong evidence that only very high concentrations of manganese in inhaled air for protracted periods of time are potentially toxic to brain cells. The ambient air exposures to manganese arising from the proposed use of MMT are infinitesimal by comparison and cannot by any justification from all presently available evidence, be used as a basis to prohibit the usage of MMT.

3) MANGANESE IS EXCRETED FROM THE HUMAN BODY.

Dietary manganese is poorly absorbed, usually 4 percent at most. Inhaled manganese may be absorbed to a greater extent through the alveolar membrane, provided that prerequisite conditions are fulfilled. When high concentrations are involved in inhaled air, occupational diseases have been observed. The same diseases have never been observed in relation to low concentrations of manganese in inhaled air. Low concentrations of manganese of inhaled air contribute very little to the body burden of manganese in most human beings. Homeostatic mechanisms exist in the body to facilitate and regulate manganese excretion. These mechanisms are not disturbed by the very slight airborne exposures that might occur from time to time.

4) MANGANESE IS NOT A KNOWN CARCINOGEN.

Various relatively short-term tests have been performed on a range of manganese compounds with no alarming results. It is noteworthy that after two year exposures of monkeys to inhaled manganese oxide, no precancerous or cancer lesions were reported by the authors (Bird). In passing, it should be noted that any compound given at toxic doses to laboratory animals has a greater likelihood of facilitating the

expression of spontaneously arising cancers. The available epidemiological evidence from miners and factory workers does not raise any suspicion of an increased risk for cancer.

5) MANGANESE IS ONLY NEUROTOXIC TO HUMANS AT HIGH MILLIGRAM INHALATION EXPOSURE LEVELS.

As indicated earlier in this document, only at very high and prolonged inhalation exposures (tens of milligrams per cubic meter of air) has there been documented epidemiological evidence of human disease. Two manifestations occur, one being neurotoxicity resembling Parkinsonism and the other being pneumonitis. These air concentrations involved are many orders of magnitude higher than those anticipated by worst case estimates of additional inhalation exposures caused by use of MMT.

6) OCCUPATIONAL SAFETY INHALATION STANDARDS ARE ORDERS OF MAGNITUDE GREATER THAN PRESENT OR EXPECTED AMBIENT AIR LEVELS.

The present TWA limits recommended by ACGIH and set as a ceiling limit by OSHA for manganese oxide compounds and dust in air in a work setting for an 8 hour day are 5 milligrams per cubic meter. There is no evidence that prolonged and

repetitive inhalation exposures of humans to this concentration of manganese oxides in air has caused any demonstrable recognized health problem. This judgement was arrived at by many scientists acting independently and jointly on various committees, after extensive evaluations of all available scientific evidence concerning occupational hazards to inhaled manganese oxides.

7) THE TOXICITY OF MANGANESE IS DIFFERENT FROM AND NOT RELATED TO THE TOXICITY OF LEAD.

Clearly, lead compounds have no known useful biological functions and have been reported by many epidemiologists and biomedical scientists to cause a spectrum of adverse health effects even at relatively low levels of human exposure. Two major sources of excessive exposure to lead exist: 1) the ingestion of lead-containing paint, and 2) lead in certain foods which previously occurred at very substantial levels especially in certain canned foods. Lead toxicity is determined by the unique characteristics of each particular compound of lead. The same is true for each and every chemical compound in the world. Certain lead salts are absorbed, slowly excreted and can cause brain and kidney damage. While the body has certain mechanisms to detoxify and

excrete lead, they are not remarkably efficient. This is probably because lead is not an essential element for body function; to the contrary, it is a very effective biological poison.

Manganese, only when inhaled in excessive amounts, causes a much more specific pattern of neurotoxic damage. This probably reflects overload beyond normal capabilities of cells to use manganese constructively. There are indications that the trivalent form of manganese is a powerful oxidant, whereas the normal function of divalent manganese is as an antioxidant. One cannot say that there is a biologically required or normal level of lead in the body. One can say that manganese is required for normal body function and only becomes toxic to brain when excessive amounts are inhaled over prolonged periods of time.

8) THE USE OF HAIR SAMPLING TECHNIQUES TO ESTIMATE HUMAN EXPOSURE TO MANGANESE HAS NOT BEEN VALIDATED.

Among experienced scientists, there is concern about the accuracy with which residues of various compounds are measured in hair and whether or not they truly reflect the past pattern of human exposure. This is because direct exposure of hair to a variety of compounds contained in air or in various

cosmetics and shampoos may confound interpretation. This is particularly true with regard to manganese because of its common occurrence in airborne dust which is deposited on body surfaces, including hair. Validation studies on this topic have been inadequate. More importantly, there are data to indicate that such findings misrepresent the body burden of manganese in humans. Quantitative analyses of 24-hour urine excretion or blood levels are likely to be more accurate, although these need further validation also.

9) WHILE DEFICIENCIES Of DIETARY INTAKES OF IRON AND CALCIUM INCREASE MANGANESE ABSORPTION, THEY ARE NOT DIRECTLY RELEVANT TO THE ISSUE INVOLVED HERE.

Many factors influence the absorption through the gastrointestinal tract of dietary components such as divalent cations. These include among others, manganese, iron, and calcium. Some exist in different states of valency. Other dietary components such as ascorbic acid also influence absorption. Iron-deficient humans or those with a propensity to absorb higher amounts of iron such as pregnant women, infants, and people with hemochromatosis will absorb higher amounts of iron than normal. By analogy, they are likely to absorb higher amounts of manganese in the diet if under

similar circumstances. These observations are largely irrelevant to the present issue involving MMT, because inhalation exposure to manganese follows different characteristics, if in fact, the inhaled manganese is absorbed through the alveolar membrane into the blood stream. It is to be expected that a significant portion of inhaled manganese will be adsorbed on other particulates and expelled by ciliary action back to the oropharynx and swallowed where it then is treated by the body as dietary manganese. As such, very little will be absorbed through the gastrointestinal tract under any set of conditions. Persons with higher than normal absorption may absorb relatively higher amounts of manganese than do most people, but most likely it will be readily excreted from the body. We see no problem in this regard as far as the proposed use of MMT is concerned.

CONCLUSIONS

Manganese is required in the diet as an essential nutrient for human health. It is usually readily excreted from the human body. It is not a known carcinogen. Its toxicity is unrelated to lead. Only when humans are exposed by inhalation for prolonged periods of time to air concentrations in the tens of milligrams per cubic meter of air, has disease occurred. Manganese does not pose a public

health risk at ambient concentrations in air, which in turn will not be significantly increased at all by the proposed use of MMT. Occupational safety standards permit orders of magnitude greater exposures to inhaled manganese than could ever under any circumstances be expected from the proposed use of MMT.

BIBLIOGRAPHIC REFERENCES

This report has been prepared after an extensive review of the worldwide literature on manganese, including both scientific publications and governmental commissioned reports. The scientific literature concerning nutritional aspect of manganese has been extensively reviewed, as has all available information on manganese toxicity.

The latter include review of EPA's Health Assessment Document, the Canadian Report, various publications by Davis, Donaldson, Gottschalk, Silbergeld, and many other reports. This database is too extensive for us fully document at this time, but any reader requiring further information as to sources is asked to telephone area code 301/320-2900.

CURRICULUM VITAE

ALBERT CHRISTIAN KOLBYE, JR., M.D., M.P.H., J.D.
7313 Helmsdale Road
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(301) 320-2900

EDUCATION:

William Penn Charter School Philadelphia, Pennsylvania	H.S.	1953
Harvard College Cambridge, Massachusetts (Pre-Med, Pre-Law and Geology)	A.B.	1957
Temple University School of Medicine Philadelphia, Pennsylvania	M.D.	1961
University Hospitals Madison, Wisconsin (Internship - Mixed Medicine)		1962
School of Hygiene and Public Health The Johns Hopkins University Baltimore, Maryland	M.P.H.	1965
The School of Law University of Maryland Baltimore, Maryland	J.D.	1966
Federal Executive Institute Charlottesville, Virginia		1974

LICENSURES:

To Practice Medicine - State of Maryland since 1962
To Practice Law - Maryland and District of Columbia since 1967
Board Certification in Preventive Medicine and Public Health

PROFESSIONAL BACKGROUND:

Internship, University of Wisconsin, Madison - 1962
Residency, Maryland State Department of Health - 1964
United States Public Health Service, Commissioned Corps - 1962-1982:

Heart Disease Control Program - 1962-1966
Staff Director, Smoking & Health Program - 1967-1968
Staff Director, Secretary's Commission on Pesticides - 1969
Deputy Director, Bureau of Foods, FDA - 1970-1972
Associate Bureau Director for Toxicological Sciences, Bureau of Foods, FDA - 1972-1982
Assistant Surgeon General (07) USPHS - 1971-1982
President - The Nutrition Foundation, Inc. 1982-1984
Director - Kolbye Associates 1984 to Present
Past President - International Society of Regulatory Toxicology & Pharmacology 1987-1988

FELLOWSHIPS AND MEMBERSHIPS:

Fellow of:
American Academy of Clinical Toxicology
American Public Health Association
American College of Legal Medicine
American College of Preventive Medicine
International Academy of Environmental Safety

Co-Editor:
Regulatory Toxicology and Pharmacology
Academic Press

Member of:
American Medical Association
American Bar Association
Maryland State Bar Association
Maryland Medical Chirurgical Society
Society of Toxicology
Environmental Mutagen Society
Society for Epidemiologic Research
Society of Ecotoxicology and Environmental Safety
New York Academy of Sciences
Toxicology Forum
Society for Preventive Oncology
International Commission for Protection Against Environmental Mutagens and Carcinogens

CHAIRMANSHIPS OR
STAFF DIRECTORSHIPS:

The Surgeon General's Reports to Congress on the Consequences of Smoking - 1967, 1968 and 1969
The Secretary's Commission on Pesticides and Their Relationship to Environmental Health, DHEW - 1969
Secretary's Representative to the Interagency Pesticide Agreement - 1970

The Health Hazards of Mercury, DHEW - 1971

Health Hazards Evaluation Board, Bureau of Foods, Food and Drug Administration - 1972-1982

Research in Human Subjects, FDA - 1972-1982

Interagency Epidemiological Working Group on Saccharin - 1976-1980

Interagency Working Group on Mechanically Deboned Meat, U.S. Department of Agriculture - 1976-1977

WHO Scientific Consultant for Preparation of Environmental Health Criteria for Nitrates, Nitrites, and N-Nitroso Compounds, Environmental Health Criteria 5, WHO Geneva - 1977

FD&C Red No. 40 Working Group - 1976-1981

Subcommittee 4 (Regulatory and Legislative) International Commission for Protection Against Environmental Mutagens and Carcinogens - 1978-1982

Interagency Working Group on Saccharin Epidemiology

Interagency Working Group on Nitrite Research

RECENT POSITIONS HELD:

Rear Admiral, USPHS - 1971-1982
(Assistant Surgeon General)

Deputy Director, Bureau of Foods, FDA - 1970-1972

Associate Bureau Director for Toxicological Sciences, Bureau of Foods, FDA - 1972-1982

President, The Nutrition Foundation, Inc.
Washington, DC - 1982-1984

PRESENTATIONS AND PUBLICATIONS:

Over 100 invited speeches and published papers concerning the safety of chemicals and foods, animals and human nutrition, and public policy issues and law.

(Detailed bibliography to be provided upon request.)

A-90-16
IV-E-9

STATEMENT OF CHEMETALS CORPORATION IN SUPPORT OF ETHYL CORPORATION'S HiTEC 3000 WAIVER REQUEST

--------S U M M A R Y--------

* Chemetals supports the Ethyl waiver request.

* Concern that manganese not be mischaracterized as a public health concern.

* Manganese does not pose a public health risk.

  - Essential to good health.
  - Average daily uptake of the human body is not affected by the use of HiTEC 3000 in gasoline.
  - Not carcinogenic.
  - Use of HiTEC 3000 does not cause exposure to manganese at levels that risk neurotoxicity or other health effects.
  - Not toxic like lead.

* Addition of manganese to the environment from HiTEC 3000 in fuel would have no adverse environmental impact.

  - Manganese is a significant global environmental constituent.
  - Introduction of manganese to the air from the use of HiTEC 3000 would be insignificant.
  - Addition of manganese to the soil from the use of HiTEC 3000 would be insignificant.
  - Addition of manganese to the water from the use of HiTEC 3000 would not pose a problem.
  - Use of HiTEC 3000 does not create a solid waste disposal problem in scrapped automobiles.

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301-789-8800

CHEMETALS

July 18, 1990

Public Docket A-90-16
Air Docket (LE-131)
Room M-1500
U.S. Environmental Protection Agency
401 M. Street, S.W.
Washington, D.C. 20460

RE: Comment on the request of Ethyl Corporation Dated May 9, 1990 for a Fuel Additive Waiver, Clean Air Act Section 211(f)(4)

Dear Sir/Madam:

Chemetals Corporation submits these attached comments on the waiver request of Ethyl Corporation for the use of HiTEC 3000, a manganese-containing additive, in unleaded gasoline in the United States.

Chemetals has been a producer of manganese alloys and chemical derivatives for over 35 years. We are the supplier of manganese chloride to Ethyl Corporation for the manufacture of HiTEC 3000. As a long time producer of manganese fine chemicals, Chemetals is concerned about allegations made during the June 22, 1990 public hearing which inappropriately suggest that manganese used in gasoline in the form of HiTEC 3000 would present a public health problem paralleling the situation with lead.

Our comments in the attachment point out that a comparison between lead and manganese is not justified. There is a wide safety margin between the levels if normal nutritional requirements and the extremely high levels where neurotoxicity becomes a concern. The use of HiTEC 3000 does not cause a shift in the current ambient levels of manganese in our environment to those levels where neurotoxicity becomes a concern.

In view of our comments in the attachment, we strongly urge your favorable action on the Ethyl Corporation waiver request for the use of HiTEC 3000 in unleaded gasoline in the U.S.

Very truly yours,

Dr. Francis J. Keenan
Director-Research & Development

Dr. Denis F. DeCraene
Director-Business Development

enclosures

cc: Mary T. Smith
Director-Field Operations
and Support Division
(EN-397F)

DFD:mrt

STATEMENT OF CHEMETALS CORPORATION IN SUPPORT OF ETHYL CORPORATION'S HiTEC 3000 WAIVER REQUEST

I. INTRODUCTION

Chemetals is a world leader in the production of manganese fine chemicals. Headquartered in Baltimore, MD, Chemetals has production facilities in Baltimore, MD and New Johnsonville, TN, and sales offices in Baltimore, MD, Pittsburgh, PA, and Brussels, BELGIUM.

Chemetals, together with Sedema S.A. headquartered in Tertre, BELGIUM (a sister company), has been manufacturing manganese derivatives for over 35 years. Our products are sold to the Agriculture, Aluminum, Battery, Catalyst, Ceramics, Electronics, Magnesium, Petroleum Refining, Steel, Water Treatment, and Welding Industries. Chemetals and Sedema market and sell their products in these industries in U.S., Europe, the Far East as well as in underdeveloped countries.

As a major producer of manganese fine chemicals, Chemetals supplies manganese chemicals to Ethyl Corporation for the production of HiTEC 3000.

II. CHEMETALS SUPPORTS THE ETHYL WAIVER REQUEST

Chemetals believes Ethyl's additive is beneficial because it reduces overall toxic emissions to the atmosphere both from the tailpipe and at the refinery, while offering options to the refiner for meeting the demands of the transportation fuel market and making a favorable impact upon the balance of trade.

We have reviewed the waiver request and find that HiTEC 3000 has benefits in terms of the auto tailpipe emissions:

1) Unburned hydrocarbons are increased slightly at the tailpipe. However they remain well below the current standard of 0.41 gm/mile and even approach the proposed standard of 0.26 gm/mile. In the test, HiTEC 3000 raised the octane level of the Mn-containing gasoline by 0.9 octane numbers. When unleaded gasoline is formulated to a given octane level, the refiner can use less of the other octane producing aromatic components to reduce tailpipe HC emissions, as well as fuel volatility.

2) CO emissions are reduced by an average of 0.22 gm/mile.

3) NO_X emissions are reduced by 0.11 gm/mile. This effect substantially enhances the ability to achieve the proposed NO_X standard.

4) Total emissions are reduced by 16%.

We also find that the data demonstrate no adverse effects upon the emission control systems.

III. CHEMETALS IS CONCERNED THAT MANGANESE NOT BE MISCHARACTERIZED AS A PUBLIC HEALTH CONCERN

As a major worldwide manganese producer, Chemetals is a member of the International Manganese Institute, Paris, FRANCE. This organization is composed of 40 member companies including most of the Free World producers of manganese ore, metal, alloys, and chemicals. The Manganese Institute is extremely conscious of the health issues relating to manganese in occupational and environmental settings. To that end, the Institute runs a committee on occupational health and the environment. This committee has the charter of preparing guidelines to educate producers and users about the appropriate ways to use and dispose of manganese derivatives in their respective applications. As a member of this group, Chemetals is concerned about the mischaracterization of manganese as a cause for health concerns in the testimony at the EPA Public Hearing on the Ethyl waiver request.

The hearing testimony was focused upon the potential effects of exposure to manganese at extreme levels and gave a skewed perspective of manganese compared to the real, overall picture.

On the contrary, manganese is an essential element to human health. Manganese plays a key role in:

a) Formation of connective tissue and bone.
b) Growth.
c) Carbohydrate and lipid metabolism.
d) Embryonic development of the inner ear.
e) Embryonic development of the reproductive function.

As the testimony at the hearing pointed out, neurotoxicity concerns develop at very high levels. However, these levels are greatly above the current normal levels arising from natural and manmade emissions. Further, the Ethyl data show clearly that the use of HiTEC 3000 does not cause incremental manganese emissions approaching these higher risk levels.

IV. HOW EPA SHOULD ADDRESS THE QUESTION OF THE HEALTH EFFECTS OF MANGANESE IN THIS PROCEEDING

In exercising its discretion under SECTION 211 (f)(4) of the Clean Air Act, EPA must consider whether Ethyl has met its burden of demonstrating that the fuel additive (HiTEC 3000) and its emission products will not cause or contribute to a failure of any emission control device or system over the life of the vehicle to achieve compliance with the emission standard for which the vehicle is certified. Ethyl has met this burden.

The Environmental Defense Fund seeks to add two additional burdens that the Clean Air Act does not impose on the applicant for such a

waiver. The Clean Air Act does not, as the EDF suggests, require the waiver applicant to prove that the additive will not affect human health or add measurably to environmental loadings of a constituent.

EPA is charged by Congress to act responsibly in exercising its duties, and its actions are properly judged in terms of the public health and welfare. Therefore, the agency may properly consider the question of manganese and its health and environmental effects. However, the base from which these considerations proceed is the currently known data on manganese. Manganese has been studied for many years, and there is a body of data that discusses what is known and unknown about its health effects. An objective review of data will satisfy the responsibility of the waiver applicant.

Reviewed objectively, these data demonstrate that EPA would act responsibly in granting the waiver for HiTEC 3000, because the incremental release of manganese to the environment, given the known health risks, does not justify a concern.

V. MANGANESE DOES NOT POSE A PUBLIC HEALTH RISK

A. MANGANESE IS ESSENTIAL TO GOOD HEALTH

Manganese is a biologially active element which is essential to good health. Deficiencies in manganese can cause disturbances in many biological processes. While its specific functions are not precisely defined, manganese plays a key role in:

Growth
Metabolism
Embryonic Development of the Inner Ear and the Reproductive Function

While the minimum daily nutritional requirement for manganese has not been precisely established, normal daily oral intake provides about 2,400 µg/day in adults. People take vitamins to assure that they receive the needed levels of vitamins and minerals, including manganese.

B. THE AVERAGE DAILY MANGANESE UPTAKE OF THE HUMAN BODY IS NOT AFFECTED BY THE USE OF HiTEC 3000 IN GASOLINE

The human body has natural mechanisms for using the manganese it needs and readily disposing of the manganese it does not. The data on manganese in the body show an excellent homeostasis in terms of manganese in concentrations well above the average daily intake. An average man, weighing 70 Kg (approx. 155 lbs.) has about 12,000 µg manganese in his entire body. Concentrations of manganese in the body do not change with age. While the average intake is 2,400 µg/day, daily intake can range from 500 µg/day up to 8,000 µg/day.

Assuming, conservatively, an average inhalation rate of 20 m^3/day of air, and an incremental peak increase of 0.0009 $\mu g/m^3$ of manganese in urban areas such as Philadelphia as a result of the use of HiTEC 3000 in unleaded gasoline, incremental increase in manganese intake from the use of HiTEC 3000 would be 0.018 µg/day. **This would be no material increase in the average daily uptake and well within the normal daily range.**

C. MANGANESE IS NOT CARCINOGENIC

Manganese is not a known carcinogen. There are no known data indicating carcinogenicity. The 1984 EPA Health Assessment Document concluded that Mn would be rated Group III using criteria established by the International Agency for Research on Cancer (IARC). Some research indicates that manganese plays an inhibiting role in tumor development and growth.

D. THE USE OF HiTEC 3000 DOES NOT CAUSE EXPOSURE TO MANGANESE AT LEVELS THAT RISK NEUROTOXICITY OR OTHER HEALTH EFFECTS

The neurotoxic effects of manganese occur only at extremely high levels. There is no arguement that high concentrations of manganese can produce neurological disorders resembling Parkinsonism and may have acute effects on the lungs. What must be clearly pointed out is that there is a wide margin between the minimal nutritional requirements for good health and the levels at which toxicity occurs.

Neurological disorders have only been observed in individuals with massive occupational exposures. All verified cases have resulted from the prolonged inhalation of dusts containing in excess of 2,000-5,000 $\mu g/M^3$ in occupational settings.

OSHA has set an air concentration limit for worker exposure to manganese that is 20,000X above ambient concentrations. The OSHA standard is 5,000 $\mu g/M^3$ for Mn dust. This standard is based on the original recommendation of the American Conference of Governmental Industrial Hygienists as a ceiling limit for manganese exposure. More recently, this widely respected group has relaxed its recommendation to a time-weighted-average (TWA) level of 5,000 $\mu g/M^3$.

The EPA has evaluated the health effects of airborne manganese and has identified no health effects at levels below 300 $\mu g/M^3$ (HAD 1984). This is 1000 times higher than current ambient levels.

Ambient levels in urban environments with point sources of manganese are in the range of 0.2 - 0.3 $\mu g/M^3$, or about 1/20,000 the OSHA standard. The Ethyl data shows that manganese emissions from the use of HiTEC 3000 in gasoline would cause an incremental increase of 0.0009 $\mu g/M^3$

in ambient manganese levels in an urban area such as Philadelphia. As shown in the following Table this would have no material impact on the ambient levels in terms of the OSHA ceiling limit, nor does it materially shift ambient levels any closer to the "safe" level as deemed by EPA.

TABLE: Comparison of Airbourne Manganese Levels Through Use of HiTEC 3000: Ambient Urban Levels vs. Levels Causing Documented Health Effects

	Mn Levels Current ($\mu g/m^3$)	Mn Levels if HiTEC 3000 Wavier Granted ($\mu g/m^3$)
Urban Areas with Point Source	0.2-0.3	0.2009-0.3009
Urban Areas in U.S., Average	0.095	0.0959
OSHA Standard	5000	-
Lowest Observed Adverse Neurological Effects Level	2000	-
Lowest Observed Adverse Health Effects Level	300	-

E. MANGANESE IS NOT A TOXIC METAL LIKE LEAD

There are vast differences between the effects of manganese and lead on the human body. Manganese is essential to the mitochondrial function and for carbohydrate metabolism. Lead has no known benefits to the body's homeostasis. Lead can show numerous acute toxicological symptoms, including encephalopathy, as a result of low levels of exposure. Only at extremely high doses for protracted periods of time does manganese have the potential to do damage to the body. OSHA has set worker exposure limits for lead are 50 $\mu g/m^3$ as compared to manganese limits at 5,000 $\mu g/m^3$ (100X higher). NIOSH states that lead compounds may be IDLH (Immediately Dangerous to Life & Health) at concentrations of 300,000 $\mu g/m^3$ while manganese is listed as IDLH at 10,000,000 $\mu g/m^3$, a vast difference. The Food and Drug Administration has designated manganese compounds, such as manganese chloride, manganese sulfate, manganese gluconate and manganese citrate as "Generally Recognized as Safe" for use as direct human food ingredients. See 21 CFR 184.446 et seq. No lead compounds are so recognized by FDA.

VI. THE ADDITION OF MANGANESE TO THE ENVIRONMENT FROM MMT IN FUEL WOULD HAVE NO ADVERSE IMPACT

A. MANGANESE IS A SIGNIFICANT GLOBAL ENVIRONMENTAL CONSTITUENT

Manganese is ubiquitous and is produced in vast quantities, in comparison to which the amount of manganese added to the environment by the use of HiTEC 3000 would be insignificant.

Manganese is universally present in the environment. Manganese is the twelfth most common element and fifth most common metal in the earth's crust. It is widely distributed in over 300 mineral species of sedimentary and igneous rock. Manganese is also a minor constituent of all coal ash. Mn is present at low levels in nearly all forms of matter: air, water, and land.

Studies have indicated that the ambient air levels of Mn vary widely from remote areas to industrialized urban areas. The value depends heavily on human activity as well as natural meteorological and volcanic activity, etc. In 1982, for urban areas in Canada and the U.S., the average level of ambient manganese values ranged from 0.065-0.095 $\mu g/m^3$, respectively. Areas with point source emitters typically ranges from 0.2-0.3 $\mu g/m^3$. Studies show that on a worldwide basis, an estimated 610 million kilograms/year of manganese are emitted into the atmosphere from natural sources compared with 320 million kilograms/year resulting from human activities. These data show that manganese is a significant presence in the air we breathe.

Manganese is present in nearly all sources of surface and subsurface water. Due to weathering of rocks and minerals, manganese is constantly being introduced into the water supplies from natural sources. Due to the action of microbes and other factors, manganese can be either oxidized or reduced. If manganese is oxidized, the soluble manganese level will drop. If manganese is reduced the concentration will increase. Numerous studies have described the transport mechanisms of manganese in such environment. Their studies have shown that average manganese concentrations range from 2.3-232 µg/l for 16 drainage basins in the U.S. In general, manganese levels are higher in subsurface water supplies. The available data show that manganese is commonly present in our environment.

As stated previously, manganese is widely distributed in mineral species. According to one study the level of manganese is:

1,000 µg/g	earth crust
2,000 µg/g	basic rocks
600 µg/g	acid rocks
670 µg/g	sedimentary rocks
850 µg/g	soils

These levels show that manganese is naturally present in dusts and soils. This substantial natural presence is the reason that natural emissions are almost twice as high as emissions due to human activities involving manganese.

The use of HiTEC 3000 will not significantly increase production of manganese. The worldwide production of manganese ore in 1987 was over 25 million tons or about 9 million tons of manganese. The large majority (80-90%) of manganese is used in the production of iron and steel. Manganese is used both to control the level of impurities in steel and as an alloying agent for numerous grades of steel. As such, nearly all the iron and steel produced annually contains up to 1% manganese.

Manganese is also essential for many other activities such as agriculture, non-ferrous metallurgy, electronic materials manufacture, catalysis, primary batteries, glass making, and water purification. Manganese is intertwined in many of the goods and processes that constitute our civilized society.

In comparison to all other known uses HiTEC 3000 would be a very small consumer of manganese. Using the extreme case, if every gallon of gasoline in the U.S. contained the proposed concentration of .03125 g manganese as HiTEC 3000, then 3,450 tons/year of manganese would be consumed. This represents less than 0.04% of the worldwide production.

The current ambient levels of manganese present in the environment due to natural as well as manmade emission are 10-100X higher than the incremental contribution of manganese resulting from the use of HiTEC 3000 in gasoline. **The use of HiTEC 3000 gasoline will have no impact on the distribution or loadings of manganese in the environment resulting from manmade emissions.**

B. THE INTRODUCTION OF MANGANESE TO THE AIR FROM THE USE OF HiTEC 3000 WOULD BE INSIGNIFICANT

One study reported the average ambient manganese concentration in U.S. urban locations to be 0.095 $\mu g/M^3$ where there were no point sources. Urban areas where there are point sources exhibit ambient manganese levels an order of magnitude higher, i.e. in the range of 0.2-0.3 $\mu g/m^3$. Other studies have shown the ambient values correlate with the level of human activity and proximity to point source emitters. In 1981, the World Health Organization (WHO) stated conclusively that there is no evidence of any health risk to humans resulting from ambient manganese levels in urban environments.

Ethyl has used EPA protocol to measure the particulate emissions from cars fueled with gasoline containing HiTEC 3000. On average, only 0.4% of the contained manganese exited the tailpipe. Ethyl has shown in their waiver request that the use of HiTEC 3000 in urban areas (such as Philadelphia) will result in a peak concentration increase of 0.0009 $\mu g/M^3$. This represents a 1-5 percent increase in current ambient levels assuming that 100% of the manganese which exits the tailpipe reports in the air. **Therefore, it is clear the use of HiTEC 3000 will not contribute a significant amount of manganese to current ambient levels.**

C. THE ADDITION OF MANGANESE TO THE SOIL WOULD BE INSIGNIFICANT

Ultimately, all airbourne manganese is deposited on water or soils. As stated above, soils contain an average of 850 µg/g of manganese. The use of HiTEC 3000 will not impact this value since natural deposition rates overwhelm those due to HiTEC 3000. Using data found in Ethyl's waiver request, the Philadelphia urban area represents 30,625 Km^2. Assuming 3.4 X 10^6 cars drive 12,000 miles per year and achieve 25 miles/gal fuel economy, there would be 1.632 X 10^9 gallons of fuel consumed. If each gallon contained 0.03125 g of manganese and 0.4% of this manganese was emitted from the tailpipe, then 204,000 g of manganese would be emitted as manganese oxides. The would result in a deposition rate of 6.7 $\mu g/M^2$-Yr of manganese assuming that 100% of the manganese emitted from the tailpipe finally reports to the soil. When one compares this to published values for New York City in 1975, which is a dry deposition rate of 36,000-80,400 $\mu g/M^2$-Yr, contributions from HiTEC 3000 would represent less than 0.02 percent increased manganese; no material change.

D. THE ADDITION OF MANGANESE TO WATER WOULD NOT POSE A PROBLEM

Manganese is a natural constituent of most surface and subsurface water supplies. A very significant amount of this total results from weathering and acid drainage of manganese containing minerals. Other sources include atmospheric dusts which subsequently dissolve or are reduced by organics or microbes.

The EPA drinking water standard for manganese is 50 µg/l. This value was set on the basis of aesthetics and not on any perceived public health hazard. Many subsurface water supplies naturally have levels much higher than this value. In the case of drinking water, manganese is easily removed by the conventional treatment techniques practiced by water treatment facilities.

The fate of manganese in surface water has been studied extensively. In most surface water systems, dissolved manganese is quickly oxidized and precipitated to become part of the sediment. However, in the case of acidic lakes (pH <5), manganese levels would be higher than non-acidic

lakes and streams. One study estimated that 4 X 10^{10} Kg/Yr of manganese enter the riverine environment on a worldwide basis. If HiTEC 3000 is used in every gallon of fuel consumed in the U.S., a maximum of 12,500 Kg of manganese/gr would enter these bodies of water via deposited dusts. Clearly, the use of HiTEC 3000 will have no material impact on current values.

E. THE USE OF HiTEC 3000 DOES NOT CREATE A SOLID WASTE DISPOSAL PROBLEM IN SCRAPPED AUTOMOBILES

The average 1989 automobile weighs 3,140 lbs. and contains 1,728 lbs. of steel. Taking into account the different types of steel used in automobiles, the average automobile contains 7.63 lbs. of manganese in the form of steel alloy. In 1989 the auto industry in the U.S. produced 6,833,097 cars. These cars contained a total of 52,136,530 lbs. of manganese (26,068 tons). There are no solid statistics on the rate of recycle for the steel from scrap automobiles. However, it is reasonable to assume that approximately 85% of this steel finds its way back into the market in some way or another. This would leave only 15% of the steel as an additional load on the environment. This calculates to 7,820,498 lbs. (3,910 tons) of manganese.

The average automobile has a lifetime of 7.6 years. During that period, that car will be driven an average of 12,000 miles per year and have an average fuel economy of 25 miles per gallon. At a fuel concentration of 0.03125 gm manganese per gallon, a total of 114 gm of manganese will be introduced into the engine and exhaust system of the car. Since only 0.4% of that manganese will exit the tailpipe, 113.5 gm (0.25 lbs.) will remain in the car to be scrapped at the end of its useful life. This represents a 3% increase in the manganese content of the scrap automobile and does not impose an unmanageable additional load on the environment.

The fate of most scrapped automobiles today is recycling. Approximately 85% of all automobiles are crushed and recycled for their steel, of which manganese is a necessary ingredient. The remaining 15% are disposed of as solid waste. The manganese content of scrapped automobiles is not regarded by RCRA as a hazard. No waste has been designated by RCRA regulations as hazardous, nor is manganese regarded as a hazardous constituent of solid waste.

VII. CONCLUSION

Chemetals finds that the use of HiTEC 3000 in gasoline causes no technical problems with the emission control systems, enhances efforts to preserve the quality of the environment by reducing total tailpipe emission, and adds flexibility to the Petroleum Refining Industry while also having a favorable impact on U.S. balance of trade.

The use of HiTEC 3000 in gasoline will not create a public health problem resulting from manganese exposure. Manganese is an essential element for good health. It is present in the environment at levels ranging from tenths of a microgram/m^3 in air to thousands of micrograms per gram in rocks and soil. The natural background levels of manganese in water ranges from micrograms per liter to hundreds of micrograms per liter.

Normal dietary intake of manganese is 2,400 µg per day. On the average the body has a manganese content of 12,000 µg. There is a wide margin between these levels where manganese is essential for good health (and is, in fact, required to prevent manganese deficiencies) and the levels at which toxicity occurs. All verified cases of toxicity have been observed only in cases where the individuals have had massive occupational exposures. In these cases, the exposure was inhalation of dust containing manganese in concentration of thousands of micrograms per m^3.

The use of HiTEC 3000 in gasoline will contribute a maximum of 0.0009 µg/m^3 of additional manganese to the current ambient levels. This contribution is one million times below the levels at which serious health concerns arise and will not materially shift ambient levels from their present natural levels.

The Ethyl data clearly demonstrate the benefits and performance of HiTEC 3000 when used in unleaded gasoline.

In the case of any substance, the possibility to conduct additional research is unlimited. In the case of manganese and its effect on the natural processes of the body a multitude of research projects have been conducted since 1970, resulting in over 400 scientific publications. There will always be questions waiting to be answered. The work of the scientific community will continue to search for these answers. The proposed use of HiTEC 3000 presents an opportunity to ameliorate important aspects of automobile pollution. There is no evidence in this large body of scientific knowledge about the health effects of manganese which justifies rejection of this proposal due to a risk relating to the use of manganese in gasoline.

HiTEC 3000 has been used in Canada in virtually all unleaded fuel for over 10 years. Air monitoring of major Canadian cities shows no measurable increase in manganese levels as a result of using HiTEC 3000 in gasoline. There have been no adverse health effects related to the widespread use of HiTEC 3000 in gasoline in Canada. With such a record of experience, there is no reason to believe that the use of HiTEC 3000 constitutes a health risk to the population of the United States.

The facts clearly show that HiTEC 3000 will not cause a public health concern resulting from the granting of this waiver.

The EPA should grant the Ethyl Corporation waiver request for the use of HiTEC 3000 in gasoline.

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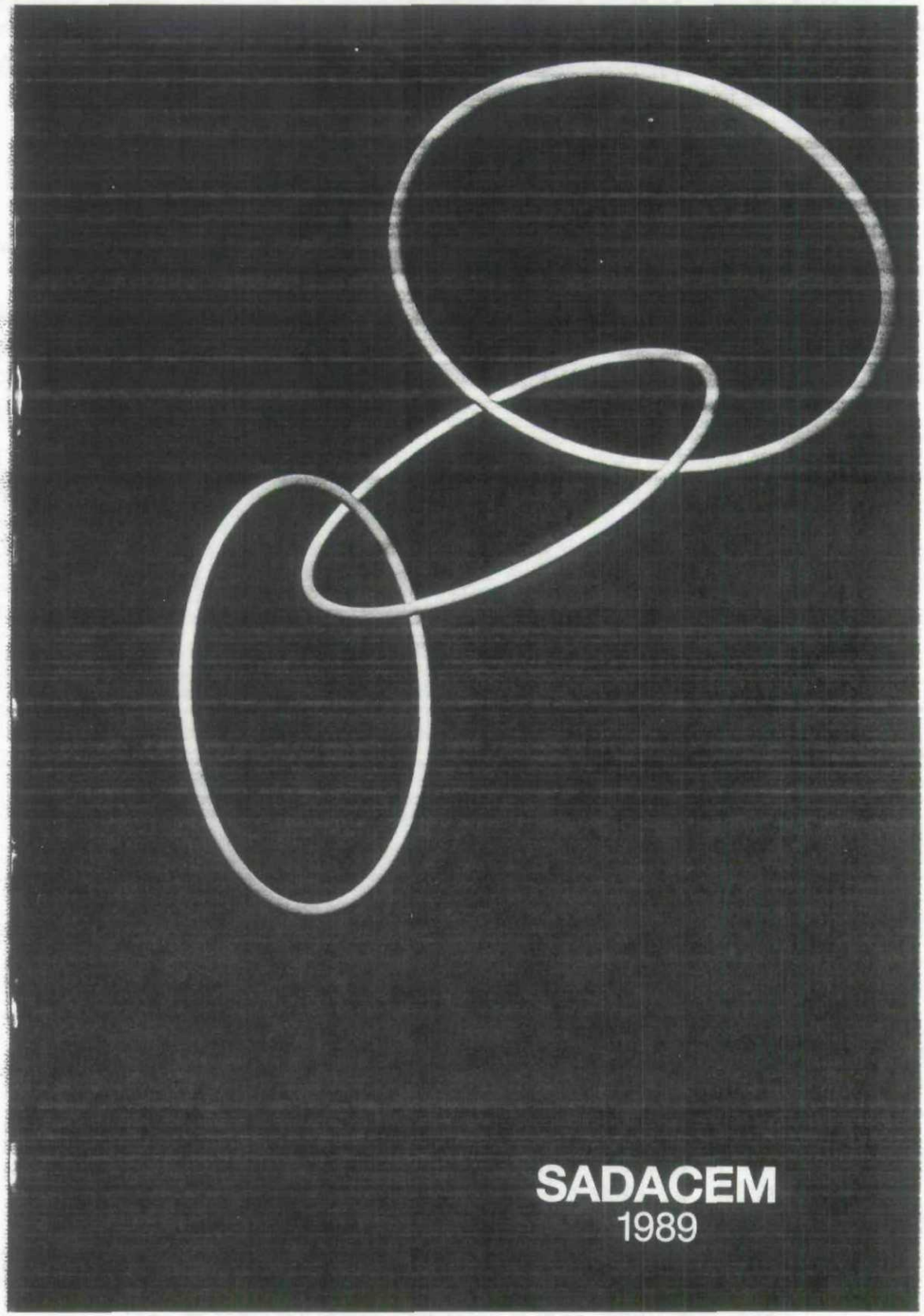
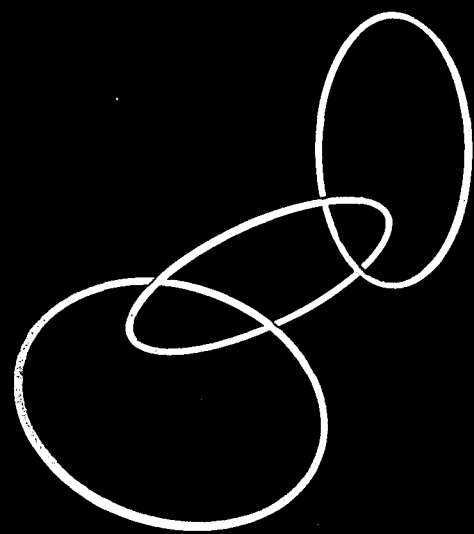

SADACEM
1989

INORGANIC PERFORMANCE CHEMICALS

ENVIRONMENTAL SERVICES

PERFORMANCE METALS AND ALLOYS



FACTS & FIGURES 1989

SADACEM

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EXECUTIVE COMMITTEE

TOWARDS EXPANSION

The severe measures taken as regards management in 1988 produced favourable effects from 1989 for all product lines. They made it possible to take full advantage of the excellent economic situation at the beginning of the financial year.

Sadacem was recognised by Gechem and by the Société Générale de Belgique as a company of significant importance whose financial structure has been strengthened.

The acquisition of MMM and its subsidiaries gave Sadacem an international marketing and sales organization, making it better equipped to consolidate its leadership positions and conquer new markets.

1989 saw the launch of a major capital expenditures program involving the modernization of the installations and bringing them into conformity with current and expected standards of environmental protection.

This dynamism would not have been possible without the joint efforts of all the staff involved. Not only have they maintained the quality of the products and technologies which give Sadacem its reputation on its markets, but they have also committed all their energy to give the company the sound basis required for future expansion.

This, in fact, constitutes the new challenge for the '90's: to develop and apply competently and creatively a successful expansion strategy.

Ludo Quirijnen
CEO

Jean Duronsoy
Chairman

SADACEM AND ITS SUBSIDIARIES

SADACEM and the companies belonging to the Sadacem Group are specialists in and electrochemical treatment of metals.

SADACEM's manufacturing facilities (7) are located in both Belgium and the United America.

SADACEM's sales are wolrdwide and its customers are active in various fields chemistry, electronics, feed and fertilizers, catalyst manufacturing, petrochemistry treatment, wood protection, steels and alloys, aluminium and magnesium production.

SADACEM's specialized sales organization also offers its skills to industrial compa related to the group.

SADACEM is organized on three strategic main segments:

* Inorganic Performance Chemicals,
* Environmental Services,
* Performance metals and alloys.

SADACEM as subsidiary of GECHEM is part of the materials sector of GENER BELGIQUE — Belgium.

KEY FIGURES

(in millions of BEF)		1989
"Industrial" sales	(1)	10,523
"Trade" sales	(2)	10,950
Total consolidated sales		21,473
Operating result		1,014
Financial result		−427
Current result before taxes		587
Tax on the current result		−30
Net current result		557
Extraordinary result		−104
Tax on the extraordinary result		−5
Net extraordinary result		−109
Total net result		448
Interests of minority third parties		−
Net profit (loss) (share of the group)		448
(3) Gross margin for self-financing		1,467
(4) Total gross added value		4,040
per employee		3.8
Sales per "industrial" employee		9.9
Fixed and intangible assets		3,701
Current charges on depreciation for the year		606
Capital expenditures for the year		689
Research & Development expenses		147
Number of employees at Dec. 31 (consolidated)		1,148
Belgium		725
USA		423

(1) The industrial sales break down into sales, excluding the value of treated metals, of BEF 8,872 million in 1989 compared with BEF 6,760 million in 1988, and the value of treated metals of BEF 1,651 million in 1989 compared with BEF 913 million in 1988.

(2) The trade sales break down into sales, excluding the value of traded materials, of BEF 424 million and the value of traded materials of BEF 10,526 million.

(3) Gross margin for self-financing: Net result + costs generating no movement of cash (depreciation, provisions and writedowns).

(4) Gross added value: Sales and services − purchases of materials − miscellaneous goods and services.

* Restated figures.

** Extraordinary charges resulting from the Gechem strategic plan approved by the Extraordinary General Mee-

RESULTS: AN EXCEPTIONAL YEAR

The consolidated sales of Sadacem increased from BEF 7,673 million in 1988 to BEF 21,473 million in 1989.

After deducting the value of metals and products of trade which are not indicative of the level of industrial activity, the representative volume of business for Sadacem progressed from BEF 6,760 million in 1988 to BEF 9,296 million in 1989, an increase of 38%.

The operating result progressed from BEF 458 million to BEF 1,014 million, an increase of 121%.

The net consolidated profit, after taxes, of BEF 448 million in 1989 compares with a loss of BEF 168 million in 1988.

During the first half of the year, business benefitted overall from temporarily high prices for certain metals and from the substantial use of the production capacity.

These results contributed significantly to the strengthening of Sadacem's financial structure.

INTERNATIONAL GROWTH

Given the nature and the quality of its products, Sadacem targets clients from industrialized countries having worldwide markets and maintains close relations with them based on an understanding of their industrial processes and their market requirements.

The acquisition of MMM in 1989 made it easier to establish an integrated commercial policy at the international level.

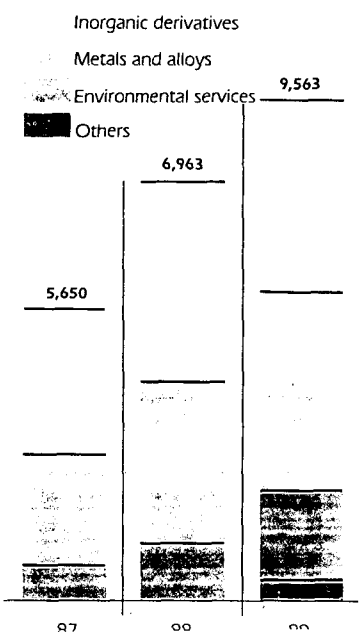
While Chemetals assumes the marketing and sales for Sadacem products in North America, these functions are gradually being coordinated with MMM, who controls distribution in all other countries from its headquarters in Brussels and through its network of agencies.

This process of integration will be strengthened in 1990.

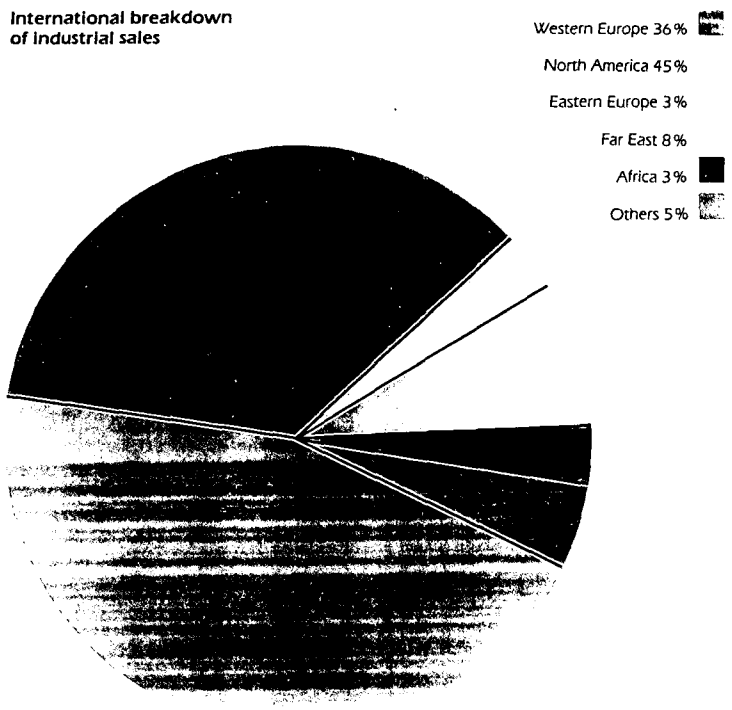
Regarding efforts undertaken to penetrate new markets, priority will be given to the development of sales to Eastern Europe. Socser, an MMM subsidiary, is already active in East Germany, Hungary and Romania. Its staff will be increased and its role in other countries of the region is currently being studied.

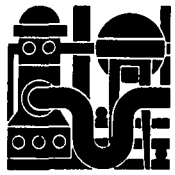
Development per sector of activity* in millions of BEF

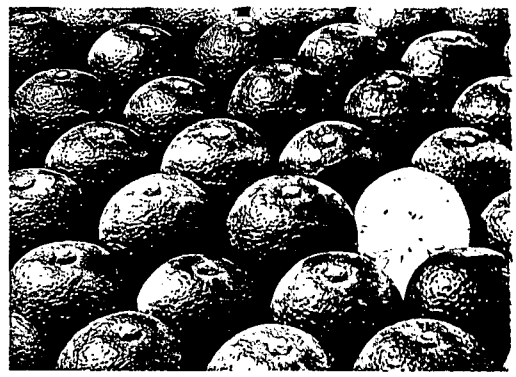
* This is the figure for consolidated sales less the value of metals and trade products that are not influencing the performance of the industrial activities of Sadacem.



International breakdown of industrial sales







INORGANIC PERFORMANCE CHEMICALS

In this sector, the majority of derivatives produced and marketed by Sadacem have a manganese base. High mineral prices in 1989 partly dampened the results achieved by increased sales. The impact of the high costs of metal ore, could persist in 1990.

Agribusiness

Sales of manganese derivatives for animal feed, fungicides, soil improvement, and wood protection were sustained at the level of previous years. Sadacem, which enjoys strong positions in Europe for these products, consolidated its market shares and is expected to maintain these in 1990.

Battery industry

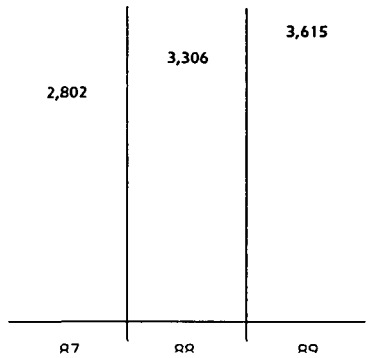
Sadacem is one of the four largest producers in the world of manganese dioxide for dry batteries.

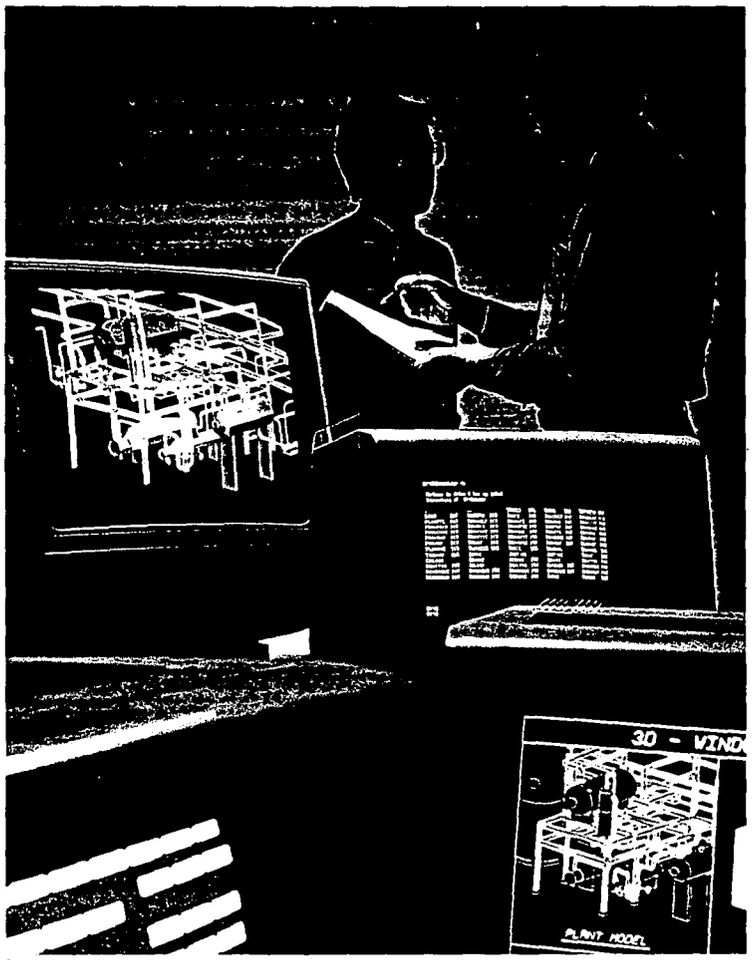
In 1989, sales of chemical dioxide for the production of ammonium chloride or zinc chloride batteries achieved a level similar to that of 1988. Sadacem has retained its market share.

The electrolytic dioxide produced at New Johnsonville (Tennessee - U.S.A.) has been approved by all the major manufacturers of alkaline batteries. The high demand in 1989 should persist in 1990. The annual factory

Inorganic performance chemicals

in millions of BEF





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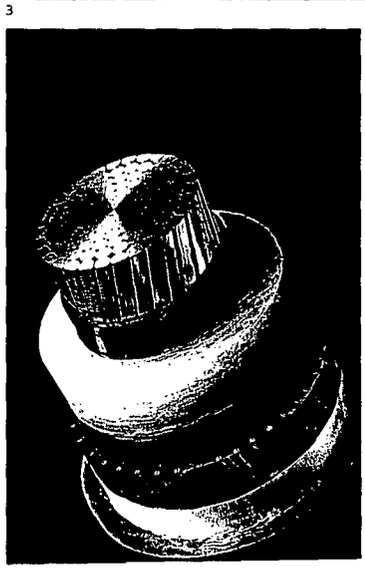


1. Manganese oxides play a fundamental role in the improvement of soil for agriculture by promoting photosynthesis and the generation of chlorophyll. **2.** CHEMETALS: Plant at NEW JOHNSONVILLE. Production of manganese dioxide by electrolysis. Transport of the finished product to the conditioning unit. **3.** The electromagnets used in the cathodic screens contain soft ferrites manufactured from manganese oxides. **4.** ENSAGRI, traditionally a producer of carbon black for batteries, has perfected a new technique for producing conductive carbon black for polymers used in the manufacture of very high voltage electric cables.

production capacity increased from 11,000 to 13,000 tons in 1989 and will reach 15,500 tons by the beginning of the second half of 1990. The economies of scale thus recorded and continuing improvement in productivity and of product quality will further strengthen the competitive position of the plant.

Sales of carbon black produced by Ensagri at Willebroek (Belgium) according to an entirely original process increased by 15% in 1989. This was due to an improvement in the performance of the product, which can be used from now on by a larger number of battery manufacturers in their regular production. Sales should continue to increase in 1990.

Moreover, the special properties of carbon black produced by Ensagri have proved well suited to the manufacture of semiconductor polymers. 1989 saw the completion of technical and marketing studies related to this application and the construction of a granulation plant was begun. This plant is expected to start up during the third quarter of 1990.

In 1991, Ensagri-Willebroek should reattain profitable status.

Electronics industry

Sadacem accounts for over half of world sales of manganese derivatives for the production of soft ferrites used mainly in the manufacture of cathode ray tubes (TV) and electronic appliances.

The high demand seen in 1989, especially in the industrialized countries of the Pacific region, promises to continue into 1990. As a result, it was decided to increase the production capacity of Sedema at Tertre. The new facility will begin operation in spring 1990.

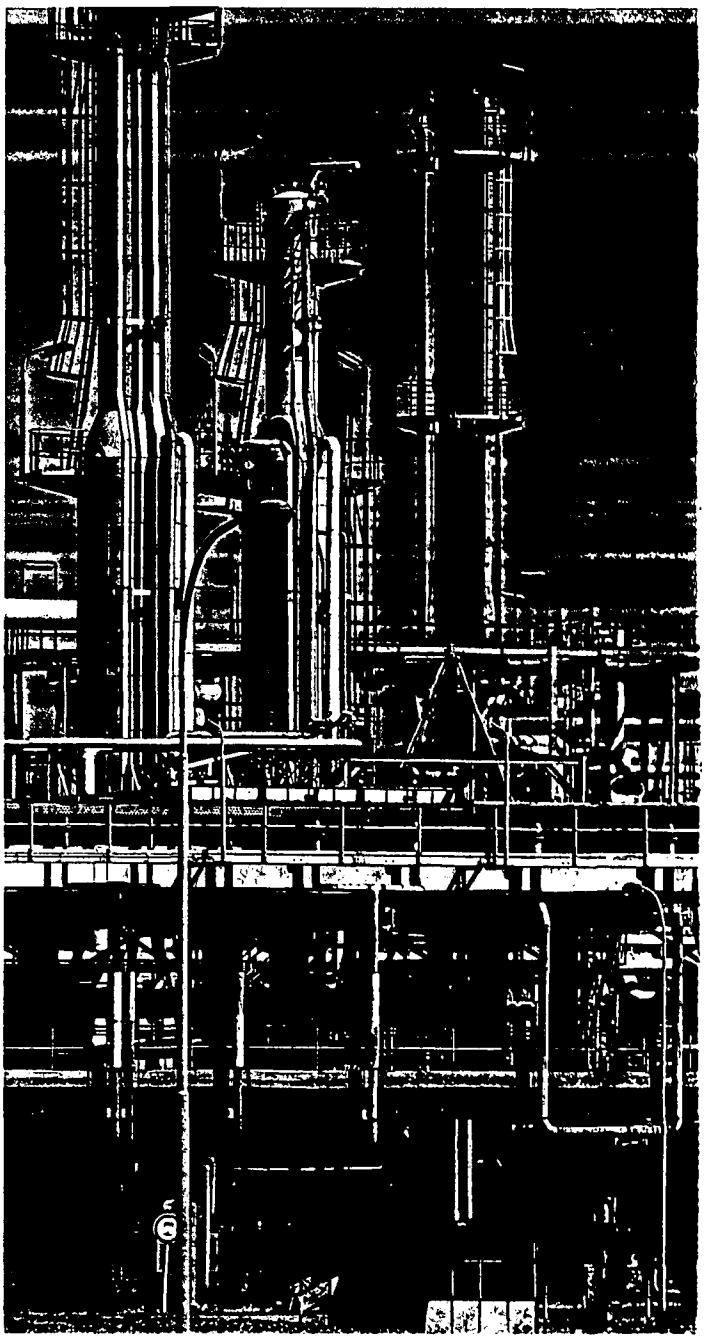
New derivatives of higher purity and even finer granulometry have already been tested by customers. These products, intended for the production of the highest quality ferrites, will extend the product range offered by Sadacem, thus consolidating its leadership in this area.

Chemical specialties

Sadacem employs its extensive knowledge of manganese chemistry to serve the specific requirements of its customers. With their collaboration, Sadacem has developed new specialties, including derivatives used in the desulfuration of gasses, the absorption of heavy metals in drinking water, the production of non-polluting "anti-knock" agents for fuels, and certain additives used in the manufacture of magnesium metal.

New possibilities in this sector of high value added products are being explored in this

ENVIRONMENTAL SERVICES



Recycling of spent HDS catalysts

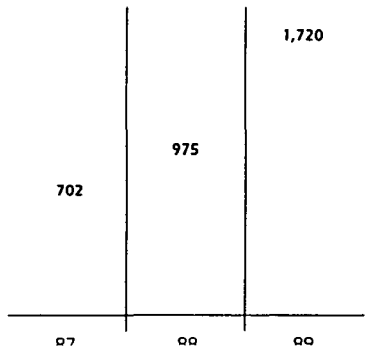
Gulf Chemical and Metallurgical Corp. (Freeport, Texas) is a specialist in claiming catalysts, used to eliminate sulfur (hydro-desulfuration process – HDS), from crude oil.

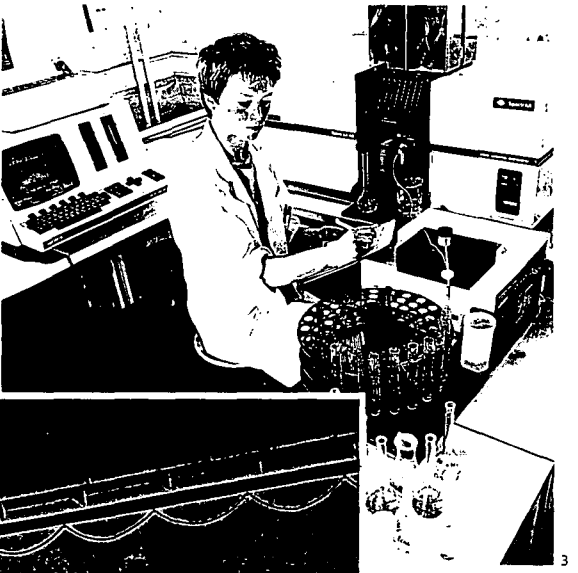
The elimination of organic products associated with used catalysts, and the recovery of molybdenum and vanadium already carried out by GCMC will be complemented during the summer of 1990 by the start-up of a second plant which will assure the total recovery of other catalyst components.

This major investment will allow a full response to the environmental problems encountered by refining companies. At the same time, a plant modernization program begun in 1989 will assure the competitiveness of the operation.

The high value of vanadium at the start of 1989 produced exceptionally favorable results.

Environmental services *in millions of BEF*





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1. The treatment of used HDS catalysts from the oil industry carried out by GCMC resolves a difficult environmental problem while ensuring the recycling of the heavy metals they contain.

2. SEDEMA, partial view of the installation for the treatment of copper wastes coming mainly from the electronics industry. **3.** An essential stage of production, quality control.

Recycling of copper wastes

Original technology developed by Sedema is used in the Tertre plant for treating liquid and solid copper wastes resulting from the manufacture of printed circuits.

After the extraction of copper, the regenerated solutions are reused for the manufacture of printed circuits.

Copper salts and oxides resulting from these treatments are used in animal feeds and for wood and plant protection.

The installation of new capacities in 1989 was necessary to respond to growing demands from the customers.

Sedema is the European leader in the chemical treatment of wastes generated by the electronics industry.

Sadacem's expert knowledge regarding chemistry and technology of transition metals has been widely sought for the development of environmental services.

PERFORMANCE
METALS AND ALLOYS

The products of this sector are used primarily in making both conventional and specialty steels.

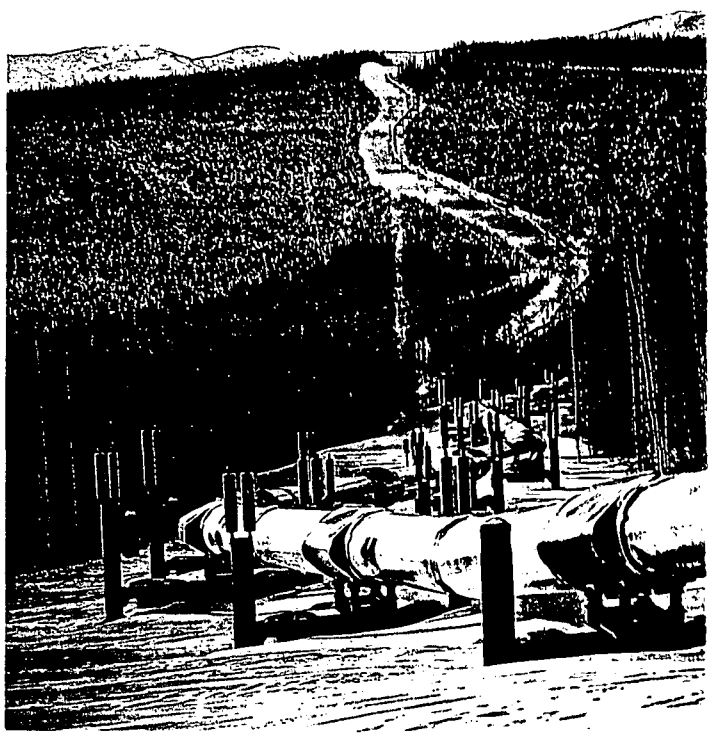
Molybdenum oxide and its derivatives

This activity of Sadaci (Ghent, Belgium) involves the conversion as a sub-contractor of molybdenum sulfide (MoS_2) into oxide, conditioned under various forms, and the production of sodium molybdate and ferro-molybdenum. Production and sales remained at their maximum level in 1989. Demand should be sustained in 1990.

Ferro-vanadium

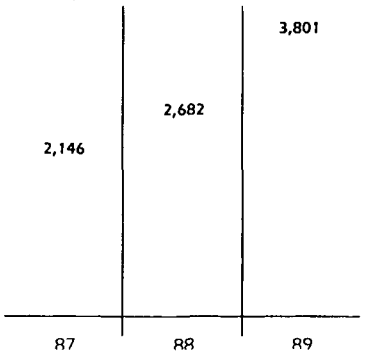
One of the three leading European converters of vanadium oxide, Sadaci benefitted greatly from the favorable economic climate for steel in 1989.

As in the case of molybdenum, our position partly as a sub-contractor insulates Sadaci from price fluctuations in the vanadium market. Production in 1990 should be approximately the same as in 1989.



Performance metals and alloys

in millions of BEF



1. SADACI, ferro-vanadium ready for shipment. **2.** SADACI, after cooling, the cast ferro-vanadium is transported to the finishing department. **3.** Ferro-vanadium and ferro-molybdenum are used in special steels intended to endure extreme conditions.

Ferro-manganese

The excellent economic climate for steel in 1989 also proved beneficial for the production of ferro-manganese. Prices were steady and, after numerous years of restructuring this activity, a return to profitability was achieved. Activity will remain favorable in 1990, although not as strong as in 1989.

Manganese metal and its derivatives

Starting with manganese metal and ferro-manganese with a low carbon content, Chemetals-Baltimore produces nitrided derivatives for use in making steel. At the New Johnsonville plant, manganese metal powder is mixed with aluminum to make briquettes for the aluminum industry.

Sales of Al/Mn briquettes were steady in 1989 and will remain so in 1990.

By contrast, the sales of low carbon ferro-manganese and of nitrided manganese dropped during the second half of 1989, following a slump in the activity of the American steel industry, the effects of which will still be felt in 1990.

Stabilization of the demand for steel in 1990 will entail a decrease in sales in this sector. Nevertheless sales and conversion services involving the specialty steels market are less sensitive to variations in the economic climate.

HUMAN RESOURCES

High level of expertise, innovative spirit and quality of customer's service, well-known characteristics of Sadacem in all its activities, have been further enhanced through dynamic teamwork centered on selected objectives.

Thanks to dedicated work of all its employees, Sadacem was able to make the best of the favorable economic situation of 1989.

The Group will maintain its policy of attracting or promoting top quality people as the key factor for its growth.

THE ENVIRONMENT: A GLOBAL PROGRAM

At the beginning of 1989, both in Belgium and the United States, Sadacem launched its program to achieve conformity to environmental requirements in all its plants in anticipation of the foreseeable demands of future international standards.

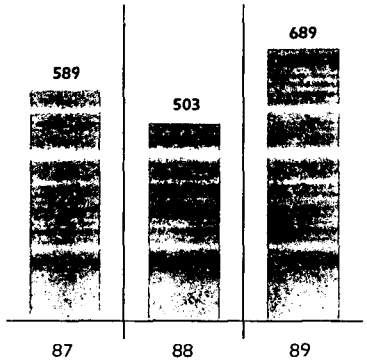
At Terre, the rehabilitation of former decantation basins was begun using methods developed by specialized university laboratories. Research is also being conducted to improve leaching processes for manganese.

In New Johnsonville, the capping of the old decantation basins was completed in 1989.

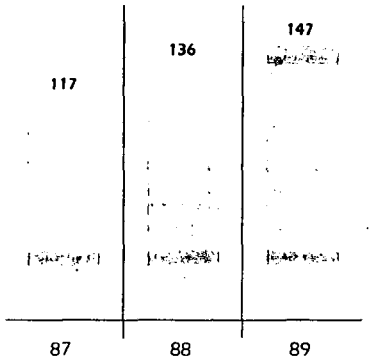
Sadacem fully complies with legal standards governing effluents, while researching ways to recover certain effluents whose disposal is currently permitted. At the same time, Sadacem endeavors to develop new manufacturing processes which will no longer require pollution control equipment.

In Ghent, a substantial capital expenditure allocated in 1989 has been contributing to the transformation of sulfur dioxide into sulfuric acid. By the end of 1990, the Sadaci factory will operate below regulatory requirements.

Capital expenditures in millions of BEF



Research and Development in millions of BEF



CAPITAL EXPENDITURES

In 1989, in addition to the acquisition of MMM, approximately BEF 1,200 million in capital expenditure were committed. Besides the replacement of equipment, these capital expenditures concern the increases in capacity for the production of electrolytic dioxide at New Johnsonville and of ferrite products at Tertre, the construction of a carbon black granulation facility for polymers at Willebroek, a treatment plant for total recycling of spent catalysts at Freeport, and a desulfurisation unit for the off- gasses of the furnace at Ghent. Finally the program for improving productivity by modernizing factories was begun in 1989 and will be continued in 1990. Including the efforts undertaken to protect the environment, capital expenditure earmarked for 1990 will amount to BEF 1,400 million.

RESEARCH AND DEVELOPMENT

In 1989, a program for developing an improved electrolytic manganese dioxide required for the fabrication of better quality alkaline batteries was successfully completed. The quality produced at New Johnsonville is approved and purchased by all major battery manufacturers.

Product research and development on materials for rechargeable lithium batteries and the perfection of a new technology for the production of chemical manganese dioxide was continued in 1989 and will form the focus of research and development work in 1990.

The development of a new product for soft ferrites has passed its pilot production phase. Samples are being tested by some of our customers.

The development of new applications of carbon black in semi-conductor polymers will be continued in 1990.

A program for perfecting production processes and for expanding the range of products available was approved and started in 1989.

PERSPECTIVES

Having successfully refocused its activities (its strong points, stabilized its results, and r turned to a substantial level of profitabili Sadacem can now confidently approach t definition of its main strategic axes of growt Studies conducted in collaboration with int national consultants will lead, at the end 1990, to the definition of precise objectives.

Despite less favorable economic forecas Sadacem should confirm its profitability 1990 thanks to improved manageme methods, increased productivity, and stren thening of commercial positions.

MARKETS

PRIMARY BATTERIES:
manganese dioxide for batteries

carbon black

AGRICULTURE:
manganese oxide, manganese sulfate; animal feed: manganese oxide and copper oxide, manganese sulfate, manganese carbonate; fungicides, oligo-elements, copper oxichloride

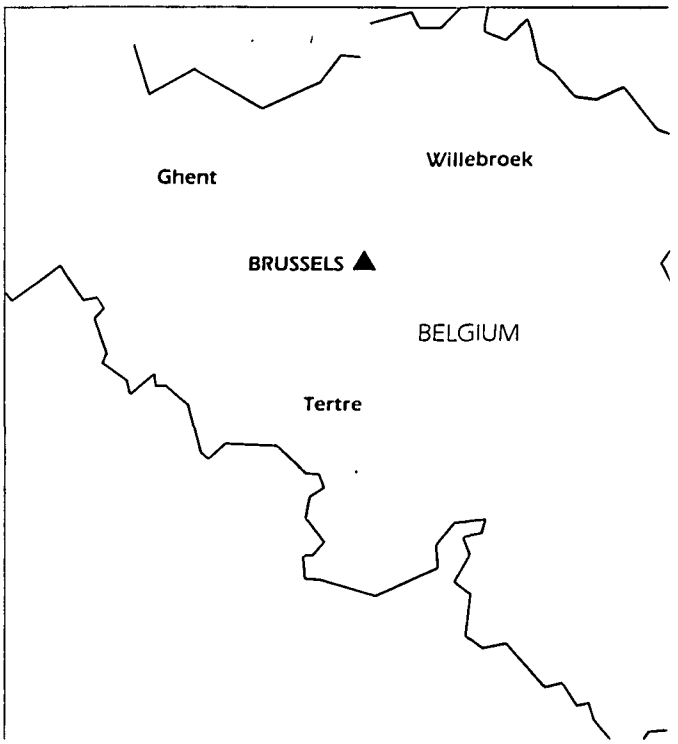
CHEMICAL INDUS
derivatives of copper, manganese, vanadiu molybdenum; carbor

ELECTRONICS:
manganese nitrate,

manganous-manganic oxide and manganese carbonate for ferrites

STEEL:
alloys and derivatives of molybdenum, manganese and vanadium

ENVIRONMENT:
treatment of spent HI catalysts, treatment o' wastes, water filtratio



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Gulf Chemical & Metallurgical Corporation (GCMC)
302 Midway Road - PO Box 2290
FREEPORT - TEXAS 77541 - USA
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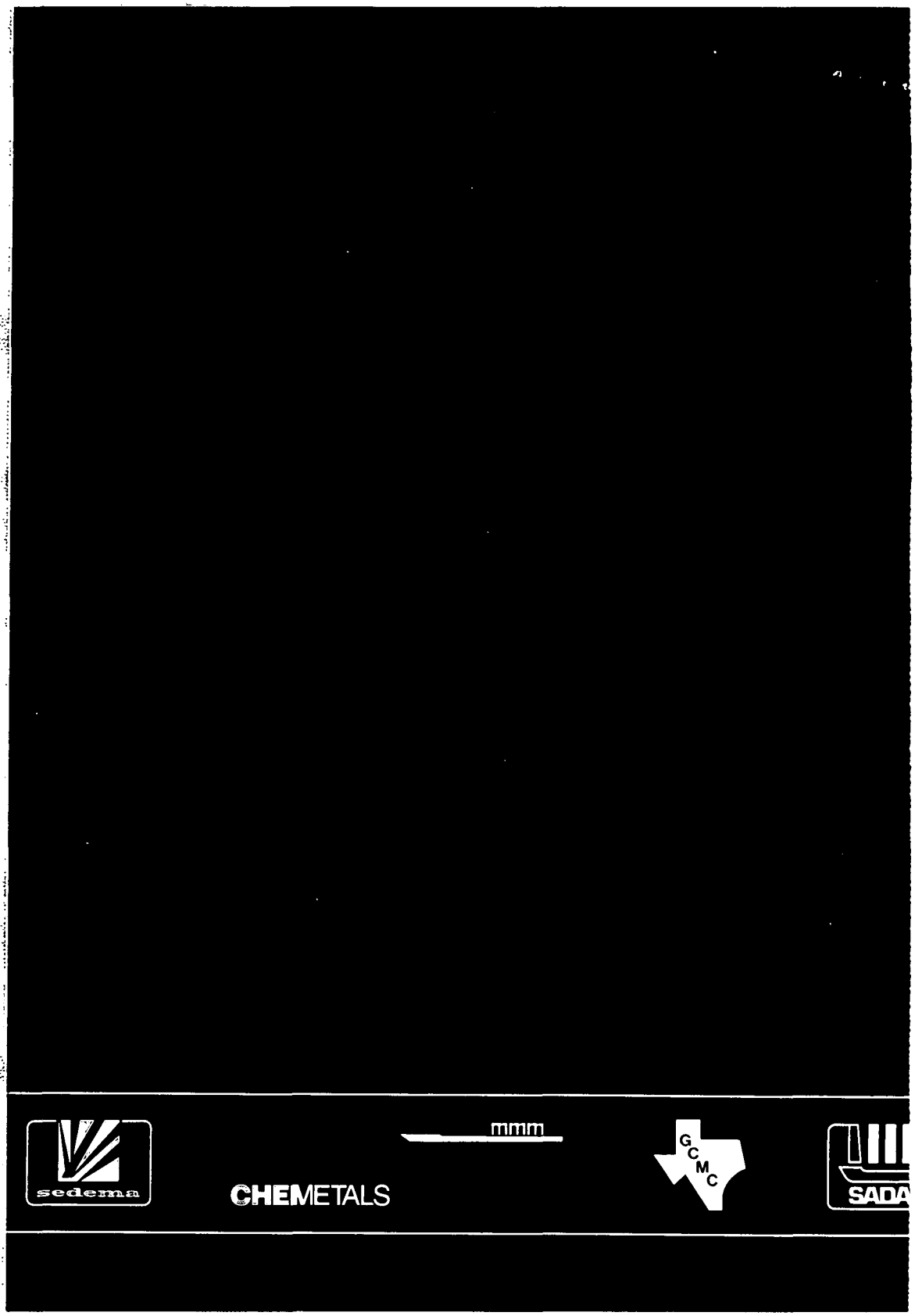
Fax: 409/233 71 71

With the collaboration of Paul Funken for the graphic art


sedema
mmm
CHEMETALS
GCMC
SADA

CHEMETALS

The Manganese Source®

Chemetals is the world's leading source of manganese fine chemicals.

Reliability, consistency, and competitiveness have been the hallmarks of our business for forty years. The measure of our success is the high percentage of our customers who rely upon Chemetals as their sole source—their Manganese Source®.

Our ability to adapt quickly and our deeply ingrained spirit of teamwork enable us to address customer needs and deliver solutions to complex problems in a rapidly changing world marketplace.

Our mission is to continually improve the quality of our products and services, deepen our commitment to our customers, support an environment in which our employees will work and grow together, generate a positive return to our shareholders, and contribute to the betterment of society— . . . Chemetals' Quality Commitment . . . within Chemetals we simply call it CQC.

Forty Years of Continuous Growth . . .

In the 1950's, Chemetals met America's need for a secure domestic source of strategically important manganese chemicals.

Chemetals' history has been one of continuous refinement of our unique technologies and expansion of our fine and performance products portfolio.

1950 Manganese Chemicals Corporation is formed and awarded a U.S. government contract to promote domestic manganese production.

1953 Manganese Chemicals Corporation opens facility in Riverton, Minnesota to produce high purity manganese carbonate from low-grade local ore.

1959 Pickands-Mather acquires Manganese Chemicals Corporation.

1962 Baltimore, Maryland chemical and Kingwood, West Virginia metallurgical facilities open to process higher grade foreign ores.

1968 Diamond-Shamrock acquires Pickands-Mather. Manganese Chemicals becomes the Chemetals Division of Diamond Shamrock.

1973 Chemetals introduces a novel process which makes possible production of high purity manganese oxides at low cost, benefitting electronics and specialty chemical producers.

1975 Chemetals perfects a process to commercially produce anhydrous manganese halide salts.

1978 SEDEMA (Belgium) acquires the Chemetals Division of Diamond Shamrock. Chemetals, Incorporated is born.

1985 The metallurgical facility at Kingwood, West Virginia is severely damaged by flood and permanently closed.

1986 In-house production of nitrided metallurgical products is re-established at our Baltimore, Maryland facility. Chemetals continues to provide customers with Kingwood metallurgical products by establishing long-term supply agreements.

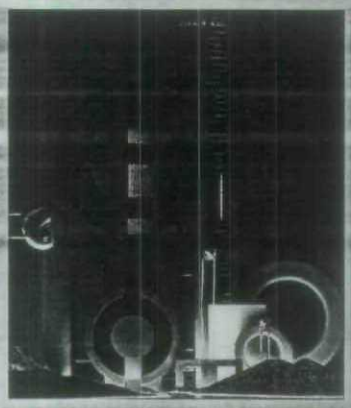
1987 Chemetals acquires the manganese business of Foote Minerals.
Chemetals introduces CST, an advanced sulfur sorbent used to protect sensitive refining catalysts.

1988 Chemetals' ultimate parent, Société Générale de Belgique, restructures. SEDEMA and Chemetals join SGB's subsidiary, SADACEM, S.A.

1989 Chemetals introduces CIR, a performance product which removes metals and sulfide from water.

An Overview of Our Customers' Applications

Electronics



Consistent quality starting materials are vital to produce miniature electronic products. Subtle changes in particle size or composition can have dramatic effects on electrical properties and reliability of finished parts.

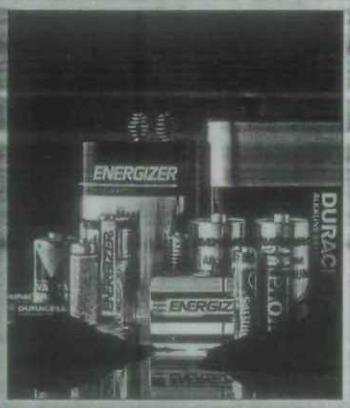
Chemetals provides manganese fine chemicals specifically designed to meet the needs of each component type.

Tantalum capacitors require manganese dioxide of controlled particle size and very high purity manganese nitrate solution.

Soft ferrite manufacturers need consistent quality manganese oxides which are particularly low in silicon and other impurities. Chemetals offers manganese dioxides and Mn_3O_4 PF.

Thermistors contain our manganese sesquioxide (Mn_2O_3). Particle size and distribution are critical.

Batteries

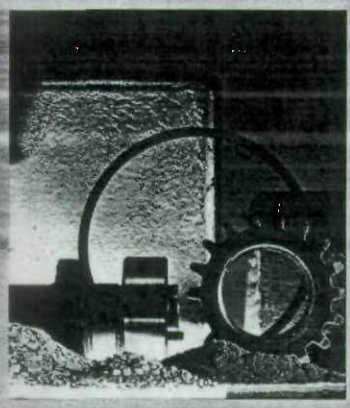


Manganese dioxide is the principal constituent of the battery cathode mix and is indispensable as a depolarizer in modern-day alkaline cells. Much of the recent improvement in cell life is attributable to improvements in electrolytic manganese dioxide (EMD) performance.

Chemetals' EMD is specifically designed for alkaline batteries. Our process utilizes titanium anodes in the electrolysis. This yields a high activity gamma MnO_2 having excellent particle size distribution and low metallic impurities.

Chemetals also supplies Sedema S.A. Faradizer M for magnesium and other specialty batteries, WSZ for zinc chloride batteries and Ensagri S.A. Super S battery black for the zinc carbon battery industry.

Metallurgical



Manganese is a necessity for steel and a valuable alloying agent for aluminum and magnesium.

Chemetals offers products designed to efficiently alloy manganese into each of these base metals:

Magnesium
Manganese chloride removes corrosion-promoting iron from magnesium alloys, vastly expanding magnesium's applications.

Aluminum
Manganese/Aluminum briquettes (Solumang 75B) add strength and corrosion resistance, and provide fine grain structures to a wide variety of aluminum grades.

Steel
Manganese is used to strengthen steel and to remove residual sulfur which causes "hot shortness."

Chemetals' products include Massive® low carbon ferromanganese; low-carbon and medium carbon nitrogen-bearing manganese alloys; electrolytic manganese metal powder; and manganese/tellurium alloying agent.

Fuel Additives

Chemetals' anhydrous manganese chloride plays a significant role in resolving a long-standing problem faced by petroleum refiners.

When refiners operate at high production levels, octane yield suffers. To improve octane levels requires additional and costly refining.

Ethyl Corporation, using our anhydrous manganese chloride, manufacturers Hi Tech 3000, a fuel additive which can be blended with fuel stocks after refining to cost-effectively enhance the octane level and enhance gasoline performance.

Fine Chemicals and Reagents

Manganese chemistry is extraordinarily diverse. Consequently, its range of applications is extensive.

Catalyst Intermediates
Manganese oxide-high purity and manganese nitrate solutions are widely used to prepare catalysts for chemical synthesis and environmental protection.

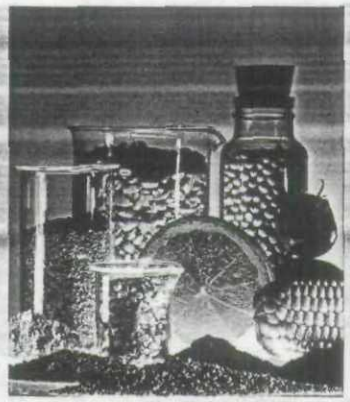
Catalysts
Manganese-based catalysts can be used to eliminate dangerous ozone and carbon monoxide.

Water Purification
CIR traps dissolved sulfide, heavy metals, and some radioactive species from water.

Sulfur Control in Refining
CST removes H_2S, carbonyl sulfide and mercaptans from petroleum refining process feedstocks.

Oxidants-Manganese Dioxide
Manganese dioxides act as a mild and selective oxidant in the conversion of alcohols to flavor and fragrance aldehydes and in the manufacture of certain dyes.

Nutrients

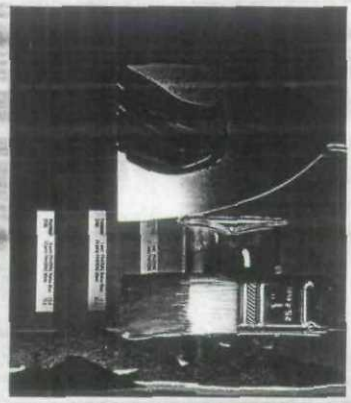


Manganese is a mineral essential for normal growth in both plants and animals.

Feed Premixes
Manganous oxide (ore grade) is added to livestock feeds, particularly for poultry, to supplement natural intake and assure healthy vigorous growth.

Fertilizer
Citrus and soybean crops suffer when soil is manganese deficient. Dry supplements introduce manganese in the form of manganous oxide. When water solubility is required, manganese sulfate or nitrate solution is the preferred product.

Glass and Pigments

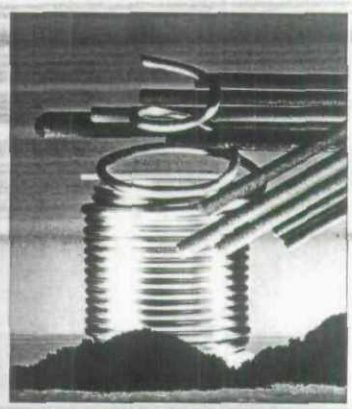


Glasses of deep amber and amethyst shades are prepared with Chemetals' high purity manganese dioxides.

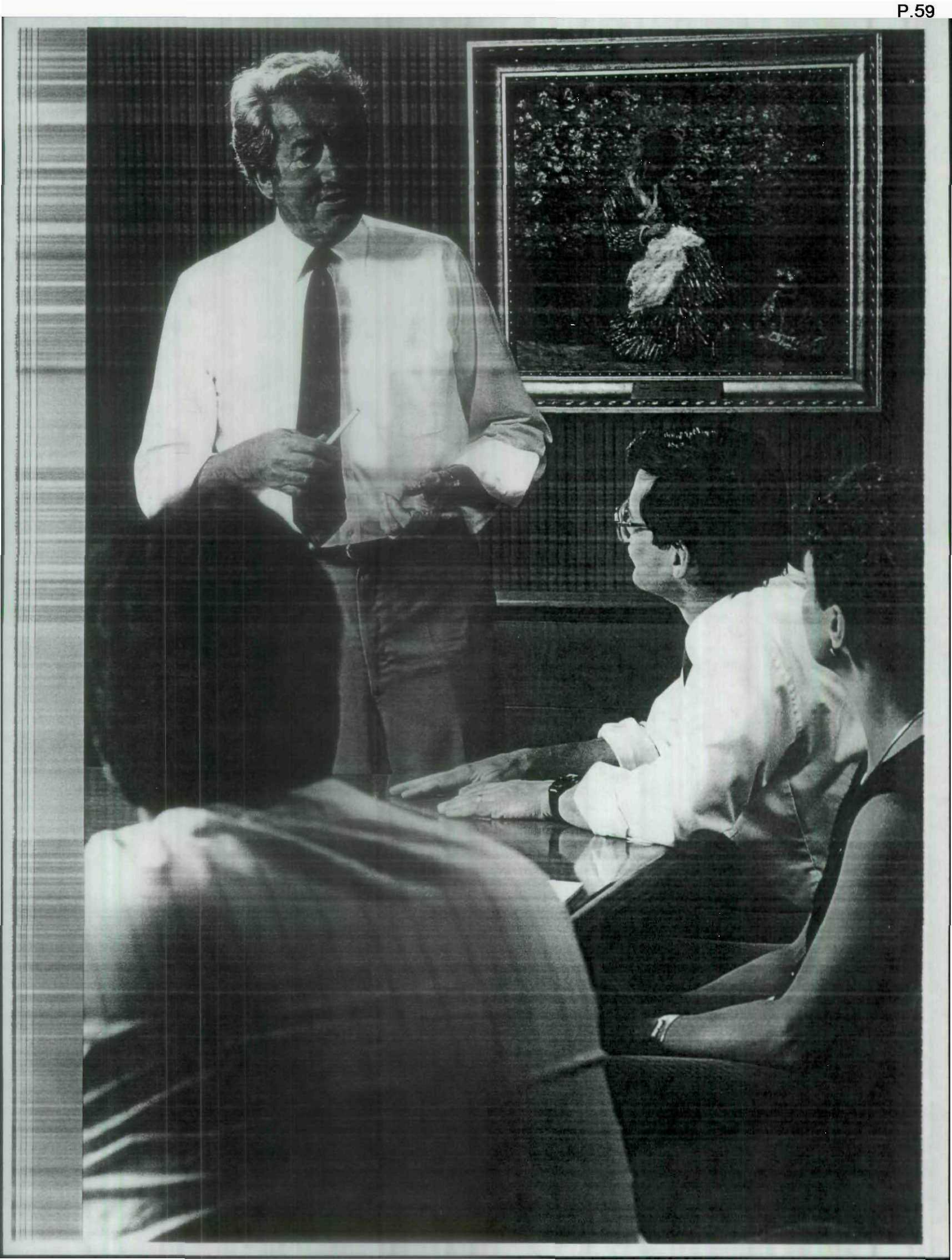
Ironically, manganese dioxide has also been used for hundreds of years to *remove* color from glasses. Sometimes called "glassmakers' soap," MnO_2 precipitates iron from the molten glass that would impart a green tint.

The thermal and light stability of manganese colorants is also a benefit to those who need both beauty and longevity in their products. In the case of vinyl siding, where color stability is essential, manganese-based pigments are commonly used.

Welding Fluxes



Manganese carbonate, manganous oxides, and weld-grade manganese powder each contributes its unique properties. For instance, manganese powder acts as an alloying agent, improving the hardenability of steel welds. Oxides are used in flux-cored electrodes for submerged-arc welding fluxes.

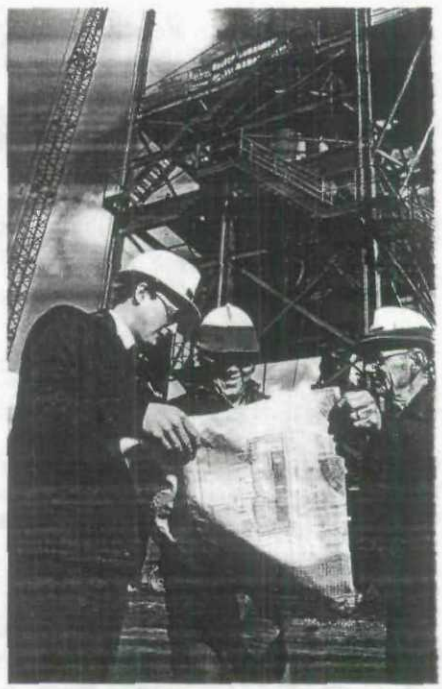


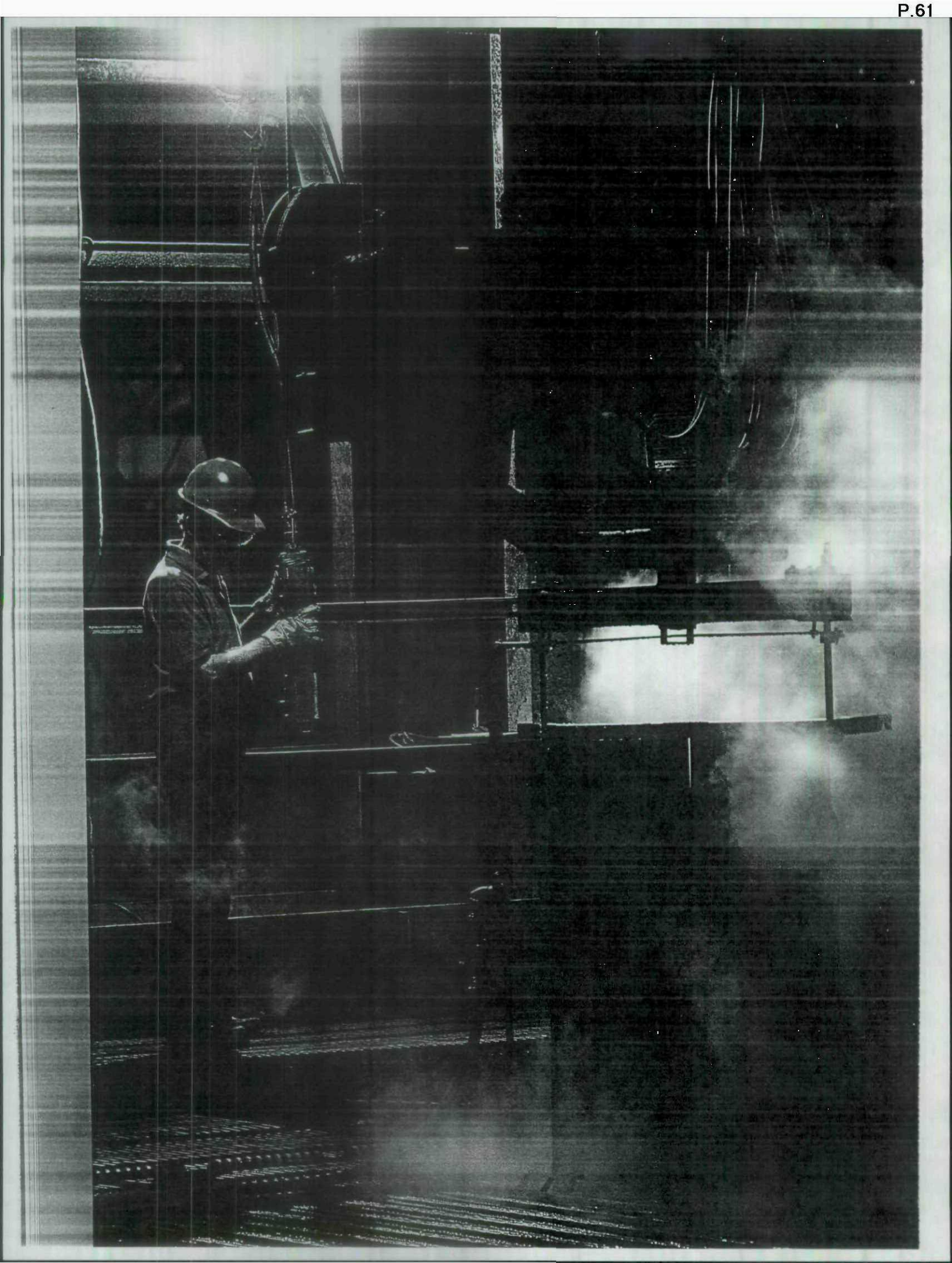
hemetals' success is a function of our people—capable individuals whose talents are enhanced by exceptional opportunities for teamwork.

Chemetals' organizational style relies on standing teams as an important instrument for action. Our business development team has been particularly productive and has allowed us to achieve an impressive success rate in commercializing new products.

Yet teamwork is successful only when individuals are committed to the process. By providing a climate where individual initiative and calculated risk-taking are encouraged, we are able to respond aggressively to new challenges.

Education is also an important factor in our corporate and personal growth: as part of our CQC program, all our employees are trained in the science of quality improvement, and the use of statistical techniques for reducing variability in product and service. Chemetals also supports continuing personal growth by funding individual study programs at local colleges and universities which lead to college degrees, advanced degrees, or simply enhance the formal backgrounds of our people.





Chemetals' Operations . . .

Chemetals is unique among manganese chemical producers. We produce a full line of fine, performance, specialty, and commodity products directly from natural ore.

We purchase those ores from multiple sources on several continents, ensuring our customers an uninterrupted supply, regardless of world political events.

Our facilities are located strategically to supply our domestic and international customers efficiently.

New Johnsonville, Tennessee

Chemetals' electrolytic MnO_2 plant is strategically located to supply both American and international battery industries. We are able to reach our customers by truck, rail, barge, or container ship. Most domestic battery manufacturers are a single day's drive from New Johnsonville.

Immediately after acquiring this facility in 1987, we began a program to make our product quality unsurpassed worldwide. Our customers tell us we are succeeding.

To continue our progress, we constantly refine the manufacturing techniques used in this state-of-the-art computerized facility. Quality testing at each step insures low product variation and optimized operating rates. Low operating costs, consistently high quality, and the ability to further expand capacity make Chemetals a capable partner for the 1990's.

Baltimore, Maryland

This plant manufactures manganese fine chemicals, including high purity oxides, anhydrous salts, specialty metallurgical products, and reduced oxide ores.

Baltimore suits Chemetals well. Its port facilities give us convenient access to our imported ores and to the large and growing number of our customers located outside North America.

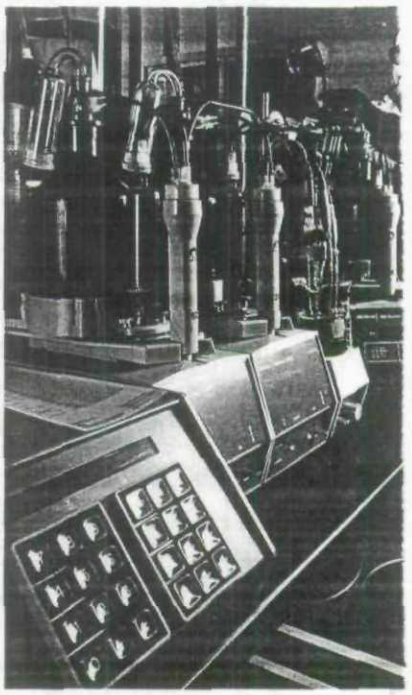
Profound changes will take place in the 1990's in the materials we use and in the methods we employ to manage the ecological impact of human activities.

Balancing the often-conflicting goals of maintaining prosperity and protecting the planet will require new and more sophisticated techniques.

Chemetals is concentrating much of its applied research in the development of materials which enable industry to reduce air and water emissions, efficiently and cost effectively. One example is Chemetals' CIR, which removes a range of unwanted metals and hydrogen sulfide from potable or discharge waters.

New generations of products will target other ecological concerns. We are aggressively seeking innovative solutions to problems, among them, control of power plant flue-gas emissions ($NO_x - SO_2$), carbon monoxide, and ozone.

Conservation of resources is also important to us. We are proud of the function our products have in stretching valuable resources. Manganese alloys of magnesium and aluminum are both light and strong, making them ideal replacements for steel in packaging materials and the vehicles to transport them. Equally important, these alloys are attractive for recycling, vastly decreasing the energy consumed in starting from raw materials.




CHEMETALS
EMD
ELECTROLYTIC
MANGANESE
DIOXIDE
NET WT. 100 lbs. (45.36 kg)
WARNING

Like manganese, Chemetals will fill many diverse roles in the future . . . as a

. . . Supplier of fine chemicals

. . . Manufacturer of performance products

. . . Developer of new technologies

. . . Strategic partner with our customers

In the future, Chemetals will continue to be *"The Manganese Source®"* . . . and more.

In North America, for more information about Chemetals' products contact:

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TEL: (32) 2-640-07-20
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TLX: 21 489

Headquartered in Baltimore, Maryland, Chemetals is an important member of the SADACEM subsidiary of Gechem, Société Générale de Belgique's materials business.

The purpose of this brochure is to provide an overview of Chemetals, Incorporated and our products. Descriptions are included to demonstrate the number and diversity of our products. They are general and are not intended to be the basis for decision-making as to the suitability of any products for a particular use or application.

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